Neurosurgical Review (2024) 47:643
https://doi.org/10.1007/s10143-024-02906-y

CORRESPONDENCE

"Navigating the risks of pediatric head trauma: the role of imaging and radiation safety"

Zainab Azad[1] · Ume Aiman[1] · Sarah Shaheen[1]

Received: 3 September 2024 / Revised: 3 September 2024 / Accepted: 16 September 2024

Abstract

Head trauma is a frequent cause of emergency department visits in children due to their larger head-to-body ratio and developing motor skills. Younger children, especially those under 2 years, are at increased risk for skull fractures due to thinner cranial bones. Accurate diagnosis of pediatric skull fractures often requires imaging, including CT scans, which raise concerns about radiation exposure and its associated long-term risks, such as radiation-induced cancers. A recent study by Ono et al. highlights the necessity of follow-up imaging in children under 24 months with isolated skull fractures (ISF) initially detected by CT. The study found that follow-up MRI scans revealed new intracranial findings in 40.6% of cases, with some requiring neurosurgical intervention. This underscores the importance of follow-up imaging in pediatric head trauma management. However, repeated imaging, particularly CT scans, increases radiation exposure, necessitating strategies to minimize it. Novel approaches like artificial intelligence (AI) are showing promise in reducing radiation doses by enhancing scan planning, patient positioning, and improving the quality of low-dose images. Despite the study's significant findings, limitations such as its retrospective design, potential selection bias, and single-institution setting restrict generalizability. Future research should adopt prospective designs, include broader case ranges, and involve multiple centers to validate findings. In conclusion, while timely imaging is crucial for managing pediatric head trauma, balancing diagnostic accuracy with reducing radiation exposure is essential. Advances in AI present promising avenues for enhancing safety in pediatric imaging.

Dear Editor,

Head trauma is a common reason for emergency department visits, particularly in children. This increased vulnerability is due to the larger size of their heads relative to their bodies, which makes them more susceptible to injuries from even minor falls. In addition, their developing motor skills and balance issues further elevate the risk of such incidents. Notably, younger children under the age of 2 face an even higher risk due to their thinner cranial bones, which are more prone to sustaining skull fractures. [1] Therefore, timely and comprehensive evaluation and management of head injuries are crucial in pediatric emergency care to ensure effective treatment and mitigate potential complications. Mostly pediatric skull fractures are diagnosed using a CT, plain radiograph, MRI, and ultrasound. [2] Frequent exposure to radiation from imaging can significantly increase the risk of side effects associated with radiation. Therefore, it is essential to explore various strategies to reduce radiation exposure for children.

A recent study by Ono et al. highlights the importance of follow-up imaging in children under 24 months with minor blunt head trauma and isolated skull fractures (ISF) on initial CT scans. [1] The study involved 741 children, 110 of whom had skull fractures. Of these, 96 underwent follow-up MRI scans, revealing new intracranial findings in 40.6% of the cases that were not initially detected. Notably, four children required neurosurgical intervention, all of whom had both skull fractures and intracranial injuries on their initial CT scans. This underscores the necessity of follow-up imaging to ensure comprehensive evaluation and management of pediatric head trauma, while also highlighting the need to minimize radiation exposure due to the associated risks.

In diagnosing pediatric skull fractures, various imaging modalities like CT scans, plain radiographs, MRI,

✉ Zainab Azad
zainabazad.19@gmail.com

Ume Aiman
aimanshahnaz285@gmail.com

Sarah Shaheen
sarahsmirza@gmail.com

1 Islamic International Medical College, Rawalpindi 44000, Pakistan

Published online: 19 September 2024

and ultrasound are utilized. However, repeated imaging, particularly with CT scans, poses significant risks due to radiation exposure. Studies have shown an increased risk of brain tumors in children following exposure to head CT scans, with the risk escalating as the number of examinations increases. In children with predisposing factors, there is also an elevated risk of developing tumors of the central nervous system, leukemia, and lymphoma. [3] Given the heightened risks of radiation-induced cancers, particularly in children, it is crucial to minimize radiation exposure in pediatric imaging while balancing the benefits of diagnostic accuracy.

Efforts to reduce radiation exposure are crucial, given the potential long-term effects of ionizing radiation. Novel approaches, including artificial intelligence, are proving highly effective in enhancing radiation protection and significantly improving safety in radiation-related fields. It was discovered that AI could be utilized in areas such as scan planning, patient positioning, and other aspects of CT imaging to reduce radiation doses, thereby improving safety and elevating standards of practice in medical imaging. [4] Furthermore, AI can be used to enhance the quality of low-dose images, further minimizing radiation exposure. Potential applications are being explored, with frameworks and procedures undergoing critical evaluation to ensure their effectiveness and safety [5].

This study presents significant findings but has several limitations. Firstly, its retrospective design may introduce biases, limiting the ability to establish causality. Additionally, by including only children who underwent imaging based on PECARN criteria, the study might have missed relevant cases, leading to selection bias. Moreover, the single-institution setting restricts the generalizability of the results. To address these issues, future research should adopt a prospective design, include a broader range of cases, and be conducted across multiple centers to enhance the reliability and applicability of the findings.

In conclusion, head trauma is a common issue in pediatric emergency care, particularly for younger children who are more susceptible due to their developmental stage. Effective management relies on timely imaging, but the risks of radiation exposure, especially from CT scans, are a significant concern. The study by Ono et al. highlights the importance of follow-up imaging to detect additional intracranial issues and guide treatment. Balancing diagnostic accuracy with minimizing radiation exposure is essential. Advances in artificial intelligence offer promising solutions to reduce radiation doses and improve imaging safety, which will be crucial for protecting young patients while ensuring effective care.

Author's contribution Zainab Azad came up with the concept and design of the study or acquisition of data or analysis and interpretation of data. Ume aiman and Sarah Shaheen helped in drafting the article and editing.

Funding This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Data availability No datasets were generated or analysed during the current study.

Declarations

Ethical approval Not applicable.

Competing interests The authors declare no competing interests.

References

1. Ono A, Ishimori S, Wada Y et al (2024) The role of secondary imaging in children aged under 24 months with proven skull fracture on initial computed tomography scan. Neurosurg Rev 47:519. https://doi.org/10.1007/s10143-024-02762-w
2. McGrath A, Taylor RS (2023) Pediatric skull fractures. StatPearls - NCBI Bookshelf. https://www.ncbi.nlm.nih.gov/books/NBK482218/. Accessed 2 Sept 2024
3. Buchberger B, Scholl K, Krabbe L, Spiller L, Lux B (2022) Radiation exposure by medical X-ray applications. German Med Sci: GMS E-J 20:Doc06. https://doi.org/10.3205/000308
4. Fiagbedzi EW, Gorleku PN, Nyarko S, Della Atuwo-Ampoh V, Fiagan YAC, Asare A (2022) The Role of Artificial Intelligence (AI) in Radiation Protection of Computed Tomography and Fluoroscopy: A Review. Open J Med Imaging 12(01):25–36. https://doi.org/10.4236/ojmi.2022.121004
5. Pashazadeh A, Hoeschen C (2023) Möglichkeiten der künstlichen Intelligenz im Strahlenschutz : Verbesserung der Sicherheit bei medizinischen Bildgebungsuntersuchungen [Opportunities for artificial intelligence in radiation protection : Improving safety of diagnostic imaging]. Radiologie (Heidelberg, Germany) 63(7):530–538. https://doi.org/10.1007/s00117-023-01167-y